United States Department of Agriculture
Agricultural Research Administration

SCIENCE AND POULTRY RAISING

A Summary of Progress in Poultry Research Conducted by the United States Department of Agriculture

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CONTENTS

January 1945

higher than usual. The additional eggs obtained during the period of higher prices thus add materially to the returns from the business. Economic reasons of this kind underlie much of the experimentation directed toward improved bloodlines.

Poultry breeding based on physical appearance of the birds results in slow and uncertain progress. A newer and better plan is to practice genetic selection. This means basing the choice of breeding stock on records of individual performance and progeny, considered in connection with those of closely related birds, especially progeny and brothers and sisters. Thus, families of high producers can gradually be established. Useful in the breeding of improved poultry is the maintenance of linebred families, signifying those composed of individuals in a particular line of descent and thus generally having similar characteristics. Most outbred matings yield better progeny than do inbred matings. However, selection of the better inbred families, for the equivalent of about three successive generations of brother-sister matings, results in some families of fair and relatively stable productiveness. Matings between birds of such families tend to give superior progeny. This method of inbreeding, followed by matings between unrelated families, parallels the production of hybrid corn, which greatly outyields its parent stock. Results of crossing inbred poultry stock of two different breeds, as well as of the same breed, have attractive possibilities. Hens produced, for instance, by mating inbred Rhode Island Red makes to inbred White Leghorn females laid about 15 percent more eggs than comparable parent stock.

Hatcherymen and poultrymen who raise chickens for meat may improve the quality of their breeding stock by selecting birds for three main characteristics--fast feathering, rapid growth, and superior conformation. This plan of selection, which begins with young chicks, does not affect the egg production of the flock, nor does it increase the cost of management, aside from the extra handling of the birds.

Fast feathering is desirable partly because it reduces the number of pinfeathers in market birds. Indications of fast feathering may be detected in day-old chicks by the length and number of the wing-feather sheaths. The best chicks for broiler stock have well-developed primary feathers (the large outer wing feathers) and also well-developed secondaries, the latter numbering six or more. The secondaries lie next to the primaries. Slow-feathering chicks have primaries that are not so well developed and fewer secondaries. The feather sheaths may be found easily in the down at the outer edge of the wings. When chicks of the desired type are selected for next year's breeding flock, they should be raised by themselves or marked in some manner--for example, by a wing or leg band.

Ability of chickens to grow rapidly is judged best by their body weight at 4 to 8 weeks of age. Those that have made the most satisfactory gains should be kept for the breeding flock. Another check may be made for growth at the age of 20 weeks, when any birds that have not come up to expectations may be removed from the special group.

Superior conformation for meat production is indicated by good development of the breast when chickens are about 6 weeks old, and not later than 12 weeks. As the breast meat is the most valuable part of a broiler, only birds with well-meated breasts should be retained for use as breeders.

In the production of broilers, the practice of crossing certain breeds or varieties has been popular and successful. Compared with the purebred parent stock, crossbreds commonly produce more meat for the feed consumed; they feather more satisfactorily; and they have less mortality during the growing period. However, crossbred pullets and hens have a tendency to be broody more often than the parent stock. The progeny from matings of Barred Rock males and either Single-Comb Rhode Island Red or New Hampshire females are especially popular for meat production. Crossbreeding is less widely used for the production of laying stock, though one advantage in making crosses between certain breeds is the ability to segregate the sexes of chicks at hatching time because of differences in the down color or feathering. For this purpose, nonbarred male breeding stock and barred females may be used, or males having gold in their plumage may be bred to silver females.

Typical results to be expected from crossbreeding are those obtained by the Department's investigators with two- and three-way crosses of Rhode Island Reds, White Wyandottes, and Light Sussex. The experiments covered 3 years. In general, the crossbred progeny were superior to standardbred Rhode Island Red pullets in rate of growth to 10 and 20 weeks of age and also matured somewhat earlier. Moreover, the crossbreds excelled in viability (ability to live) signifying less mortality. Those of the two-way cross were 6 to 10 percent better and the progeny of the three-way cross were approximately 15 percent better in this respect. However, the crossbreds were no better than standardbred stock in annual egg production, egg weight, hatchability, and weight of mature birds.

The Department's breeding operations designed to produce a small turkey of good conformation have been successful in spite of the fact that normal-size turkeys showed considerable resistance to dwarfing. The type of such a bird has been reasonably well fixed and the new turkey has received the name, Beltsville Small White, so-called from its place of origin (Beltsville, Md.), small size, and white color. Several hundred such birds of acceptable quality have already been produced, and the stock is being disseminated through hatching eggs distributed among interested State experiment stations. Considerable commercial production has resulted from redistribution of eggs or birds from the stations to commercial breeders.

Small-type young toms weigh 13 to 17 pounds at market age; young hens weigh 8 to 11 pounds--roughly about two-thirds the weight of mature standard-size birds. The body is compact, with an abundance of breast meat. The legs and neck are relatively short.

In breeding both chickens and turkeys, the use of artificial insemination has intriguing possibilities both scientifically and commercially. A few years ago Department workers developed a simple method of obtaining semen from chicken and turkey males and a method of inseminating the females. 1/ Since excellent fertility has been obtained by artificial methods the

1/ Detailed instructions for obtaining semen and learning to inseminate artificially are given in Circular No. 525 entitled "Artificial Insemination of Chickens and Turkeys."

use of the technique has stimulated much interest in this method of breeding. However, except in turkeys, artificial insemination is not yet extensively used commercially. Research workers, however, have used the technique to effect fertilization when birds could not or would not mate naturally. For example, it has been used to make crosses between bantams and standardbred varieties of chickens. Artificial insemination is used by some nutrition investigators to fertilize the eggs of hens kept in batteries so that information on fertility and hatchability on experimental diets may be obtained.

On the practical side, a few poultrymen have used the technique to fertilize hens kept in batteries. Semen from proved sires can be successfully diluted to inseminate a large number of females, so that the usefulness of a valuable male may be greatly extended. However, breeding hens are not usually kept in batteries and many breeders would prefer to mate a proved sire naturally with an unusually large number of hens, risking some infertility, rather than to undertake the additional labor of insemination.

In turkeys, however, particularly in the Broad-Breasted variety, there has been a considerable amount of infertility and many turkey breeders have used artificial insemination to improve fertility in their flocks.

Persons who prefer not to engage in poultry-breeding operations but rather to purchase stock, either as day-old or larger birds, may do so also with prospects of obtaining much better stock than was available several years ago. Coordinated Federal, State, and commercial activities have been directed toward a wider use and better supervision of improved breeding methods. Examples of this trend are the National Poultry Improvement Plan for chickens and a similar plan for turkeys.

Practical poultrymen benefit by these developments in several ways. In chickens, bred-to-lay stock representing any one of four progressive breeding stages is readily obtainable from hatcheries and breeders. The turkey plan puts most emphasis on efficiency in meat production. For both species of birds, official flock and hatchery inspections and other forms of supervision provide reasonable assurance of obtaining the degree of quality desired.

As a further guide to persons seeking superior chickens, the Department of Agriculture now issues, annually, a directory of birds that have qualified for U. S. Register of Merit. This is the highest breeding stage in the National Poultry Improvement Plan.

Recognition is given to sires and dams on the basis of the productivity of their daughters, of which at least a third of those entered in the next highest stage (U. S. Record of Performance) of the plan must have annual records of 200 eggs or more. Other requirements cover acceptable size of eggs and physical characteristics of the birds. More than 11,000 birds have thus far met the specified high standards. As evidence of the egg production to be reasonably expected from daughters of U. S. Register of Merit dams, officials in charge of the National Poultry Improvement Plan report that the average production of 21,650 such daughters, in 1943, was 205 eggs a year.

The prospective use of airplanes for transporting hatching eggs long distances, both domestically and abroad, has prompted experiments to determine whether this mode of travel would affect their hatchability. Eggs and similar cargoes usually are carried at an altitude of about 7,000 feet, though sometimes as high as 12,000 feet in crossing mountains such as the Rockies. In laboratory experiments, reduced air pressures equivalent to such altitudes and even higher ones did not affect hatchability of the eggs under test. In fact most of the eggs hatched after 3 days' exposure to a rarefied atmosphere equal to that at 15 miles above the earth. It thus appears that the altitudes at which commercial airplanes fly have no adverse effect on the hatchability of eggs.

To help poultrymen attain wartime-production goals, specialists of the Bureau of Animal Industry who administer the National Poultry Improvement Plan have sponsored, since 1943, the use of "Victory cockerels" to head hatchery supply flocks. A Victory cockerel signifies production breeding equal or superior to that of "U. S. Certified" cockerels, which is an advanced breeding stage of the plan. Because of the superior production of their female progeny, birds of this quality soon increase the egg production of average flocks about 10 percent.

The improvement plans for both chickens and turkeys are based on research which has shown conclusively that egg-laying ability and capacity for meat production are both inherited. Selective breeding, the culling of nonlayers or poor layers, and judging parent stock from their offspring thus have a dependable scientific basis.

Egg Quality Improved

Eggs of superior shell quality, interior quality, and keeping quality tend to establish greater consumer satisfaction and likewise to reduce marketing losses and costs.

Research on thickness, porosity, and related qualities of eggshells, as judged by shrinkage of their contents during storage, indicates that these characteristics are inherited. The results of studies made with two divergent lines of chickens indicate that shell quality can be improved through family selection of breeding birds on the basis of blood lines that produce eggs of low shrinkage in storage.

Studies on the interior quality of eggs have shown, among other things, that the presence of blood spots in eggs is hereditary. Consequently it is advisable to eliminate from breeding flocks birds that lay eggs containing blood spots. This condition is the cause of considerable loss to producers, market agencies, and consumers. The studies failed to substantiate a common belief that handling birds, moving them about, or frightening them causes their eggs to contain blood spots. The study showed, also, that because many blood spots are very small--less than a thirty-second of an inch in diameter--candling is only about 50 percent efficient in detecting them in either white or brown eggs. This finding places additional emphasis on the desirability of culling out birds that are known to produce eggs having blood spots.

Still other research in poultry breeding has disclosed hereditary differences in the relative quantities of thick and thin albumen in eggs, in the stability of the albumen, and in the rate that eggs lose moisture in storage. Judging from the results obtained, the keeping qualities of eggs can be improved through selective breeding based on retaining those birds whose eggs excel in desirable characteristics.

Advances in Poultry Nutrition

Since approximately half the expense of poultry production is for feed, there has been widespread interest in new developments in poultry nutrition. Studies of the protein requirements of growing chickens have shown that the birds make their greatest gains, in proportion to feed consumed, when the diet contains about 21 percent of protein. A diet containing much more or less than this proportion proved to be definitely less efficient. However, after full growth of the birds is attained, the proportion of protein may be reduced, with satisfactory results, to about 16 percent for laying stock and to as low as 13 percent in a maintenance ration for male chickens.

As a result of the war, some common feedstuffs have become scarce or entirely unobtainable. Others, though available, are too costly to use for poultry. Typical of the latter feeds are dried skim milk and dried buttermilk, which are in considerable demand for human use. A general appraisal of feeds early in the war, led to a search for new ones that might be suitable for poultry. One result of the investigation was the finding that proteins of vegetable origin may constitute up to about 80 percent of the total proteins in well-balanced diets, which is a higher percentage than was formerly thought to be practicable. Since vegetable proteins are generally cheaper than those of animal origin, this knowledge had a practical bearing on economy of production. Research on soybean meal, which is available commercially in large quantities, showed that this feed, when properly cooked or heat-treated, is an excellent feed for poultry. Among the feedstuffs not ordinarily used extensively for poultry, the grain sorghums--yellow milo and hegari--were found to be equal in value to corn in a well-balanced diet for laying hens. A safe course for the poultryman is to use diets developed and tested by public research agencies or reliable commercial organizations.

A practical consideration in the preparation and storage of poultry feeds is the retention of certain nutrients, notably, vitamin A. A study of alfalfa leaf meal, prepared both in dehydrated form and as a sun-cured product, showed a slight loss of vitamin A in 7 to 9 months and a pronounced decrease after 2 years. The convenience and economy of getting feeds in considerable quantities are thus partly offset by some decrease in feeding value when they are not used up with reasonable promptness.

In the search for new sources of vitamin A, the investigators found acorns of the willow oak, Quercus phellos, to be unusually potent in this nutrient. As much as 20 percent of them in the diet appeared to have no harmful effect, though 2 percent or more caused the flesh of chickens to become yellow and the intensity of color increased with the quantity fed. The general results of the experiment indicated that acorns, used in small quantities, may serve as the sole source of vitamin A in poultry feed mixtures.

One of the newer research findings is the value of cow manure as a source of vitamins for growing chickens. It appears that bacteria in the rumen, which is the first and largest stomach of cattle, are able to synthesize thiamine, riboflavin, and certain other vitamins from common feeds. Several investigators have found that material taken from the rumen has a higher vitamin content than the feed the animal received. This knowledge indicated that manure might be a good source of some vitamins in chicken feeding. Experiments conducted by the Department of Agriculture to explore this possibility showed that the addition of carefully dried cow manure to a low-grade diet improved the growth of chicks but did not influence their growth when their diet was adequate. The investigators found, among other things, that the manure had a marked beneficial effect on growth of chicks, if added to a diet deficient in riboflavin. They determined, also, that the dried manure contained a factor that stimulates comb growth in both male and female chickens.

Tests of both the white and dark meat of chickens that received as much as 10 percent of dried manure in the diet failed to disclose any undesirable odors of flavors. Notwithstanding the encouraging results obtained, the use of cow manure as a source of vitamins is not yet advised by this Department, pending further research including the possibility of disease transmission. Consumer reaction to the practice of feeding such a substance needs also to be considered.

With the increasing trend toward artificial incubation and brooding, which result in keeping large numbers of chicks together, feather picking, toe picking, and cannibalism have tended to increase, sometimes causing heavy losses. Research has shown that these three vices can usually be stopped by increasing the salt content of the diet. Adding 2 percent of salt to an all-mash diet or 4 percent to a mash fed with a grain or grain mixture, for 2 or 3 days, is a late recommendation that supersedes a former one recommending smaller quantities of salt.

Studies of the feed intake of laying chickens showed that when the quantity of feed was restricted to 87.5 and 75 percent of the normal consumption, egg production was reduced about 25 and 50 percent respectively. However, these degrees of feed reduction did not affect the size of eggs or the live weight of the birds.

As a guide to the quantity of water needed by adult chickens, studies conducted in Arizona showed that the average bird consumes between 18 and 20 gallons a year. The chief influences on the amounts used were found to be weight of the bird, environmental temperature, and number of eggs produced. Though showing that a fowl consumes considerable quantities of water the requirements mentioned do not necessarily apply to other parts of the country.

In a study of the effect of different percentages of fat in the diet on the hatchability of eggs, levels ranging from 0.8 to 8.8 percent failed to have any effect on either hatchability or the time at which death of embryos occurred. This subject was investigated because of a current trend toward two extremes, one high and the other low. The former is the very extensive use of vegetable oils as carriers of fat-soluble vitamins. The opposite extreme is the commercial extraction of as much of the fat and oil as possible in the preparation of meat scrap and oilseed meals. In the light of the results neither extreme is cause for concern.

Feed records of experimental birds have shown that, in general, chickens require more feed per unit of gain as they become older. An investigation of the calcium and phosphorus requirements of laying chickens led to the conclusion that a marked excess of calcium has an adverse effect on hatchability.

In a study of the functions of the gizzard, this organ was found to be unnecessary for digestion. One male bird from which the gizzard was removed, surgically, lived for 4 years after the operation.

A study of the composition of poultry showed that neither female nor male turkeys put on much fat before they are 20 weeks old. Female turkeys then fatten considerably faster and put on more fat than the males. Males thus have more lean meat and, if most of the fat is discarded in the preparation of the bird for cooking, males are a better buy than females. Unless especially fat birds are desired, market turkeys should be sold by the time they are 28 weeks old.

In feeding of turkeys, fish oils of all kinds should preferably be omitted from the diet after the birds reach 8 weeks of age. When such oils appear to be necessary in the diet of turkeys older than 8 weeks, the quantity should not exceed one-eighth of 1 percent and the quality of the oil should be high--no rancidity. Fishmeals, also, should be omitted from the diet of turkeys older than 8 weeks or restricted to very small amounts.

An interesting phase of poultry feeding that has both commercial and scientific aspects is the effect of various substances on the color of egg yolks and to some extent on the color of the whites. For instance, more than 5 percent of cottonseed meal in the diet tends to cause mottled yolks if the eggs are stored for several months, and the white may acquire a pink tint. Some plants, notably cheese weed, (round-leafed mallow) have a similar effect on the white. Pennycress and shepherd's-purse are reported to produce a green color of both the yolk and white. Although the accuracy of such reports has not been confirmed by Department research, it is a good general policy to restrict the feed of laying chickens to products and plants known to be desirable for the production of high-quality eggs having yolks and whites of acceptable appearance. Within the range of such acceptability when eggs having light-colored yolks are desired, the flock should be kept in the laying house or confined to bare yards and should have a diet containing little or no yellow corn and little alfalfa meal. To provide yolks with rich shades of yellow, one should feed diets that include an abundance of yellow corn and 5 to 10 percent of alfalfa products. Fresh green feed tends to increase the color of the yolks, but too much may cause an undesirable greenish yellow or reddish yellow color.

The use of strongly flavored feedstuffs, such as turnips, onions, and garlic, especially in large quantities, may produce objectionable flavors in eggs. Certain fish oils may produce a fishy flavor but cod-liver oil or sardine oil of good quality, fed at proper levels, ordinarily has no undesirable effect on egg quality. When birds are fattened for market,--as already mentioned in the case of turkeys--the use of strongly flavored feeds, especially in the later stages of fattening, should be avoided to prevent the possible development of objectionable flavors in the meat.

Other information of a more specialized character points to opportunities for producing medicinal or therapeutic eggs. Eggs rich in iodine are obtainable by including 5 percent of ground dried kelp in the feed given chickens. Another method of producing "iodine eggs" is to mix 1 or 2 parts, by weight, of potassium iodide with enough common salt to make 100 parts and include 1 percent of this mixture in the feed. The use of iodine eggs has been recommended abroad for a number of physiological conditions. Such eggs would seem to be of value, for instance, in regions where goiter is prevalent. Although presenting this subject as a matter of scientific interest, the Department does not recommend the use of iodine eggs or any other medicinal eggs, except on the advice of a physician.

Gains in Disease Control

Since average death losses among growing chickens and laying hens add about 2 cents a dozen to the cost of producing eggs, there is a definite economic advantage in keeping a flock in better than average health. More than 50 different diseases and parasites constitute a threat to poultry raising. The preferred first step in dealing with an unfamiliar disease is to determine the cause, as a basis for applying appropriate control measures.

Pullorum disease, one of the most insidious and devastating of all poultry maladies, no longer takes the heavy toll it formerly exacted from the poultry industry. The National Poultry Improvement Plan established in 1935, and now operative in 45 States, contains specific provisions for the control of pullorum disease. The plan has four progressive pullorum-control classes, which represent different stages in the suppression of the infection in breeding stock and deal with related steps for the protection of hatching eggs, hatcheries, and chicks against infection by pullorum organisms. The key to most of the control work is a rapid and simple test--the stained-antigen rapid whole-blood test--developed by Department scientists for diagnosing the disease in breeding stock. On the basis of the current volume of testing and relative survival rates of chick in tested and untested flocks, this test probably saves the poultry industry more than $12,000,000 a year.

The chief precaution in dealing with this highly infectious malady, which breeding stock transmit through the egg, is to be sure that new stock--either mature birds or newly hatched chicks--are from properly pullorum-tested sources. One of the newer research contributions to pullorum disease control, announced in 1943, was the use of an improved medium for producing the stained antigen used in the test. The new medium consists of colloidal sulfur suspended in glycerol and affords a greatly increased yield of the bacteria needed for preparing the antigen.

Avian tuberculosis--the form of tuberculosis common in poultry--has long caused serious losses, especially in the Midwestern and North Central States. Official methods used in controlling and eradicating the disease have included both the physical examination of birds and tuberculin testing, followed by the removal of infected birds. In a survey, reported in 1943, of the fowls on 7,536 farms, about 1 farm in 6 proved to be infected and 1 fowl in 29 reacted to the tuberculin test. More than 300,000 birds were tested. Useful means of prevention are sanitary precautions; the prompt culling and disposal of old birds, which are the ones most often diseased;

and the complete separation of poultry from swine. Such separation is a protection to swine, which are readily susceptible to the avian type of tuberculosis.

In the control of the parasitic disease, coccidiosis, preventive medication with sulfaguanidine, one of the sulfa drugs, has been found effective. This treatment to a large extent, prevents severe coccidiosis in chickens. At the same time it permits a sufficient number of the infective organisms to develop in the birds to immunize them against the highly fatal form of cecal coccidiosis. Indications are that sulfaguanidine will be useful in preventing severe outbreaks of intestinal as well as cecal coccidiosis in fowls.

Continued heavy losses inflicted on the poultry industry by fowl paralysis and other forms of the avian leukosis complex have stimulated both State and Federal research, now actively in progress. Paralysis and other nerve involvements, although frequent expressions of the disease, represent only one type. The inclusive term "avian leukosis complex" is appropriate because of the varied manifestations of this disease. Practically all tissues, organs, and other parts of the body have been found to be involved. Thus far no drug, vaccine, feed, or other product has been found to be of value in controlling this infection, which causes an annual loss of about $100,000,000 to the poultry industry of the Northeastern and North Central States. Recommended methods of prevention are sanitation, quarantine measures, and a minimum exchange of poultry stock. The use of breeding stock from families of high viability offers promise of reducing losses from this group of diseases. Extensive experimentation on the avian leukosis complex is being conducted at the Regional Poultry Laboratory, East Lansing, Mich., in cooperation with 25 State experiment stations.

Investigations of poultry diseases have disclosed, among other results, that considerable numbers of young chickens and turkey poults die from carbon monoxide poisoning. Such poisoning occurs chiefly in poorly ventilated brooders heated by coal or oil. Most of the losses occur during cold nights when the brooders are closed tightly to retain the heat and prevent drafts. Deaths of chicks and poults from monoxide poisoning have frequently exceeded those caused by pullorum infection and other infectious diseases. Prevention is both simple and obvious--namely, (1) to keep stoves and chimneys clean and in good working condition, and (2) to provide good ventilation.

An experiment conducted by the Department to determine the value of sanitation in controlling worm infections in chickens consisted in keeping containers of feed and water on wire platforms and in excluding birds from ground, beneath shelters, contaminated by chicken droppings. Such protective measures reduced roundworm infections by about 35 percent; but there was no appreciable benefit so far as tapeworm infections were concerned, because tapeworms develop in insect intermediate hosts which fly or wander extensively from place to place. As a general principle, sanitation is distinctly beneficial, but the amount of protection depends partly on the thoroughness with which sanitary conditions of the kind feasible to provide are maintained, and partly on the type of danger.

The problem of removing gapeworms from poultry, aside from laborious and dangerous removal by hand, has been solved by the use of a simple dust treatment. Finely powdered barium antimonyl tartrate is introduced with a dust gun into a box containing affected birds. The dust, when breathed by the birds, kills or loosens the worms and the chicks cough them up. The Department has prepared and distributed detailed directions for treating birds for gapeworms.

Poultry Management Becomes More Scientific

Besides the care that poultry receive in connection with modern methods of breeding, feeding, and disease control, many other practices affect their earning power and general well-being. These concern housing, equipment, exercise, and other items that comprise poultry management. In this miscellaneous field, research and practical experience have worked together in evolving numerous improved and profitable practices. Some of these differ from those advised and followed even as recently as 5 or 10 years ago. As an aid to wartime food production, the National Poultry Advisory Council, comprising leaders in all major branches of the poultry industry, has been active for several years in bringing improved practices to the attention of poultrymen, through publications, posters, radio programs, and otherwise. Typical recommendations that the Council and research workers have evolved or that they consider to have a valuable scientific basis, are, briefly, as follows:

Move portable brooder houses to clean ground, before the chicks arrive, as a defense against coccidiosis, roundworms, and tapeworms. The term "clean ground" refers to land that has not been used by chickens or turkeys or been fertilized by poultry droppings, within 2 years. As an added precaution against the same dangers, do not permit chicks or poults to mix with older birds, and do not permit visitors to enter brooder houses or yards.

For litter in brooder house, use deep absorbent material. Begin with at least 2 inches and add new litter each week until the total depth is about 4 inches. Crushed corn cobs, shavings, dry sawdust, or a good commercial litter is suitable for the purpose, but not straw alone unless cut into lengths not exceeding 2 inches. For the first 5 days while the chicks are learning what and where to eat, keep the litter covered with sacks or building paper. Stir the litter at least three times a week. Unless an infectious disease occurs, the built-up litter need not be changed during the brooding season.

The use of litter as described reduces the danger from a serious attack of coccidiosis. As a further protection against the same disease, fill in low places around brooder houses with clean gravel. Another point helpful in keeping chick mortality low is ample light in brooders. Without good light many chicks will not learn to eat and drink and death losses consequently will be high. The color of light is much less important than the intensity. Studies show, however, that neither color of light nor its intensity during the first 16 weeks has any effect on the final live weight attained, egg production, or the fertility or hatchability of eggs.

The use of a deep absorbent litter is advisable in laying houses as well as in brooders. Begin with a depth of 3 inches and increase to about 6. Besides reducing disease hazards, it helps insure against lowered egg production. House pullets in buildings or laying shelters by themselves--never add pullets to a flock of old hens even though the hens have been carefully examined and appear to be in perfect health. The reason is that adult birds, even though showing no visible symptoms, may transmit several infectious diseases. The National Poultry Advisory Council has issued many other recommendations, with the concurrence of the Department of Agriculture. Because of their wide distribution and present acceptance and use, further discussion of them is omitted from this circular.

The use of artificial lights, to supplement natural daylight, especially in winter, has been the subject of much discussion among poultrymen. Artificial lights have been observed to affect both molting and egg production of mature stock. Most molting hens resume egg production under the stimulus of artificial light. During a 3-month molt period (December, January, and February) the rate of production of experimental birds receiving artificial light was about 40 percent--signifying an average of 4 eggs in 10 days. By contrast the rate for control birds that received only natural winter daylight during the same period was about 15 percent. No known light stimulus, however, affects the normal one-egg-a-day limit to hens' rate of egg production.

It has not yet been possible to conduct research on all the problems that affect the design of poultry houses. However, in order that poultry raisers and builders of poultry houses may have the best up-to-date information on poultry-house planning and design, the Agricultural Research Administration with the assistance of State agricultural experiment stations, extension workers, and industry have compiled such information on poultry laying houses, from the standpoints of efficient use and good construction. Recommendations as to house design are based largely on the concensus of qualified persons. It may later be necessary to modify some of these recommendations as research develops more desirable designs and practices. Plans of poultry houses and equipment appear in books of farm building plans that may be consulted in offices of county agricultural agents. Publications of the U. S. Department of Agriculture and State experiment stations, dealing with the housing and management of poultry, describe and usually illustrate well-designed poultry houses, and equipment for the proper care of poultry.

A practical problem that concerns thousands of chick buyers every year is the effect of railroad shipment on the livability and later growth of chicks obtained from hatcheries. To obtain information on this point, the Department's investigators arranged for the shipment, by express, of several thousand newly hatched chicks of known ages and weights. Different lots were in transit, without feed or water, for about 24, 48, 72, and 96 hours. Some chicks in each lot were then brooded for 2 weeks and the remainder for 8 weeks. The results were definitely in favor of short shipments.

The chicks that had been in transit the shortest time and that weighed the most when first fed had the lowest mortality and weighed the most also at 2 weeks of age. Short shipments and good weight go together because

chicks that arrive promptly lose only a little of their original weight. Surviving chicks that had been in transit longest and that lost the most weight during the shipments were, on the average, only 95 percent as heavy at 8 weeks of age as those that were in transit only a short time. In general, therefore, it is advisable to avoid long shipments, especially when chicks of desired quality can be obtained nearby.

In a comparison of the relative merits of rearing chickens on range and in confinement, from the standpoint of meat production, experimental evidence favors the former practice. There is a tendency toward better development of breast and leg muscle when chickens are produced on ranges. In other words, exercise helps to make meaty wishbones and drumsticks.

The keeping of chickens in batteries is a fairly new practice. Where chickens are raised indoors, they must be kept under the strictest sanitary conditions and fed properly balanced rations containing some vitamin D supplement. The battery method is most commonly used by hatcherymen and specialized broiler producers. It is particularly adapted for holding chicks for 1 to 2 weeks and for raising broilers in complete confinement. However, only a small percentage of market broilers are raised in batteries. Batteries are also used to some extent for brooding chickens, for brooding turkey poults, and for keeping laying hens.

Batteries are usually made of angle iron, galvanized steel, and electrically welded wire. Some batteries are made of wood with wire floors. They vary greatly in type, size, and capacity, depending on the available floor space and the size of the birds. From one to five decks are provided in the batteries and each deck is equipped with wire floors, pans, or belts for the droppings and troughs for feed and water. Most batteries for young chicks are also equipped with automatic heating devices and temperature controls.

Research on the keeping quality of eggs has shown, in particular, the desirability of keeping yards and poultry houses dry and of providing clean nests with ample nesting material. The studies showed that soil-type bacteria of the Pseudomonas group may penetrate eggs within a few hours after they are laid, causing green rots. Eggs so affected in the early stages often escape detection during candling, but subsequently contribute enormously to the bacterial count of dried egg products. Since the infection takes place rapidly, washing does not prevent contamination of the egg contents. Thorough cleanliness is necessary to offset this danger.

Refrigeration of Poultry

Another line of poultry research has dealt with the effects of refrigerated storage on the quality of poultry meat. In recent years the general commercial trend in the storage of poultry has been toward lower temperatures. Instead of 10° F., formerly a common storage temperature for poultry, the present practive is to use temperatures of 0° F., or below. Another practice that has come into more general use is that of drawing chickens before storing them. These developments made it desirable to investigate their effects on various characteristics of the meat.

Using temperatures of 0° and -20 F., and storage periods of 1, 2, and 3 years, the Department's scientists found that dressed chickens lost less weight at the lower temperature. Also, the palatability of birds stored at -20° was rated higher than that of birds stored at 0°. The outward appearance of the dressed chickens, as indicated by color, bloom, condition of the skin, and degree of "freezer burn," decreased in attractiveness with increasing length of storage. The effect was less marked at the lower temperature.

Drawing appeared to have little effect, either favorable or unfavorable, on the flavor and aroma of the cooked meat when birds had been stored for 1 or 2 years. At the end of 3 years, however, the palatability of the thigh meat of undrawn birds was affected adversely. The experimental chickens were fattened Barred Plymouth Rock and Buff Orpington cockerels, some light and others heavy. Breeding and weight did not appear to have any material influence on the results.

The studies led to the general conclusion that temperatures as low as -20° F. are favorable to maintenance of quality in dressed poultry, as shown by external appearance and palatability.

New Processed Poultry Products

Requests frequently received by the Department for information on the curing of poultry meat, especially that of turkeys, have led to studies and results having promising practical applications. Dressed and drawn turkeys weighing about 16 pounds have been satisfactorily cured in about 3 weeks by the use of a brine solution followed by smoking. Turkeys prepared in this manner were in good condition after 4 weeks of storage at 68° F. The brine consisted of approximately 13 percent of salt, 6.4 percent of sugar, and 0.4 percent of saltpeter. Curing was conducted at a temperature of about 38°. Smoking the cured turkeys for 16 hours at 140° produced a desirable color--better than that obtained by 20 hours of smoking at 110°.

Consumer reactions to the flavor and texture of smoked turkey meat have varied, though for the most part are favorable. The product is of fine texture and in both taste and appearance somewhat resembles a high grade of smoked ham.

There has long been need for a method of keeping fresh eggs satisfactorily for several weeks without refrigeration. One promising method of attaining this goal, useful under various circumstances such as travel in warm climates, is a hot-water treatment. The value of this method, first reported by the University of Missouri, has been confirmed by Department tests, which were directed further toward determining the range of time and temperature that would cause the eggs to keep well but not coagulate the white. The results of the studies showed that eggs at room temperature (70 - 75° F.) could be treated either for 4 minutes at 144° or for 44 minutes at 124° with about the same result. Besides stabilizing the white of the egg, the treatment stops embryonic growth and destroys many bacteria that cause spoilage in untreated eggs.

A discovery resulting from wartime research early in 1944 was a satisfactory means of preserving wet-picked chicken and turkey feathers, millions of pounds of which had been wasted annually. Wet feathers normally decompose too rapidly to permit th eir collection from poultry dressing

plants and shipment to feather-processing establishments. Furthermore most dressing plants lack feather-drying facilities, which are expensive The preservative is made by dissolving 15 pounds of common salt and 1 pint of commercial concentrated hydrochloric acid in 30 gallons of water for each 15 pounds of wet feathers to be preserved. A tight 50-gallon wooden barrel makes a convenient container for this quantity of solution. Thorough stirring is advisable to make certain that all feathers are exposed to the preservative. They should remain in the preservative about 8 hours; a common practice is to keep them there overnight. The solution costs initially only about 1-1/4 cents per pound of wet feathers treated. The expense is further reduced by the fact that several lots of feathers can be preserved in the same solution before its value is spent.

Practical tests have shown that feathers preserved as described will keep well for at least a month, which is time enough for them to be gathered and processed.

Animal-fiber research occasioned by wartime demand for large quantities of down or a satisfactory substitute has shown also the feasibility of making a soft downlike product from chicken and turkey feathers. Feather fiber has excellent insulating and heat-retaining properties and is suitable for use in sleeping bags, padded garments, pillows, and similar articles. It consists of ground feathers from which the quills have been removed. Separation is accomplished with currents of air of regulated intensity. Another product--fractionated chicken feathers--is obtained by separating the fine, soft feathers from the coarse ones. Air currents are used in the process also. The results of both developments--preserving and processing--point to new and valuable uses for large quantities of feathers that previously were allowed to spoil. One intriguing use is the manufacture, from chicken feathers, of insulating board for keeping hen houses warm.

Progress Reports on Current Research

As seen from the foregoing text, the products of research are widely variable in character. At any given time, they also vary in stage of completion. Some are fully perfected and in widespread use; others are partly completed; and still others are in an exploratory stage, meriting at best only tentative conclusions. In the last class is the prospective value of borax, added to feed or drinking water, for preventing coccidiosis in chickents. Results of limited experimentation in this field have been distinctly encouraging. Another field of study is the seemingly positive influence of hormones (endocrine secretions) on egg-clutch sequence, which determines the time than hens lay. The rhythm of the physiological mechanism that causes shedding of the ripened egg yolk by the ovary is believed to be controlled by the concentration of hormones in the blood stream. Studies are in progress to determine how this mechanism operates and whether it can be regulated, to advantage, in poultry and egg production.

Other promising lines of experimentation include the testing of the new insecticide DDT, which appears to be very effective against poultry lice when used in the form of a dust. It is also promising for control of poultry mites and fowl ticks when applied as an oil solution to infested poultry houses and equipment. The value of DDT in kerosene as an insecticidal spray for the control of flies has been established and such sprays may play an important part in the control of intestinal worms and certain poultry diseases carried by flies.

Still another promising line of experimentation is the use of phenothiazine as a delousing agent when dusted into the feathers of chickens. Phenothiazine is already well established as an excellent drug for combating internal parasites of livestock but its effectiveness for external parasites, such as chicken lice, is still in the experimental stage. In this connection it must be remembered, however, that phenothiazine is a dye and that the feathers of white chickens are likely to be discolored.

For the further information of research workers, extension specialists, and others interested in scientific poultry studies, the Agricultural Research Administration and its constituent bureaus issue annual reports which summarize the progress of new developments shortly after they occur. The Experiment Station Record issued monthly by the Department and the annual reports of the Office of Experiment Stations are further sources of research information. Serving the technical field is the Journal of Agricultural Research, which reports current results of both Department and State experiment station research.

Persons desiring details on future developments in the fields here briefly discussed are referred to those sources. Current information on the status of poultry research at any time is available also from the Agricultural Research Administration.